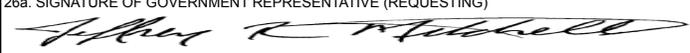


INTERAGENCY AGREEMENT		1. IAA NO. 31310018F0009			PAGE OF 1 3	
2. ORDER NO.		3. REQUISITION NO. RES-18-0077		4. SOLICITATION NO.		
5. EFFECTIVE DATE 04/23/2018		6. AWARD DATE 04/23/2018		7. PERIOD OF PERFORMANCE 04/23/2018 TO 05/01/2019		
8. SERVICING AGENCY ALBUQUERQUESANDIA NATL LAB ALC: DUNS: 155505027 +4: DOENNSASFO CONTRACTING OFFICER PO BOX 5400 ALBUQUERQUE NM 87185-5400  POC Christine Whitley TELEPHONE NO. 505-844-3811				9. DELIVER TO MARK FUHRMANN US NUCLEAR REGULATORY COMMISSION 11555 ROCKVILLE PIKE ROCKVILLE MD 20852		
10. REQUESTING AGENCY ACQUISITION MANAGEMENT DIVISION ALC: 31000001 DUNS: 040535809 +4: US NUCLEAR REGULATORY COMMISSION ONE WHITE FLINT NORTH 11555 ROCKVILLE PIKE ROCKVILLE MD 20852-2738  POC Jeffrey R. Mitchell TELEPHONE NO. 301-415-5074				11. INVOICE OFFICE US NUCLEAR REGULATORY COMMISSION ONE WHITE FLINT NORTH 11555 ROCKVILLE PIKE MAILSTOP O3-E17A ROCKVILLE MD 20852-2738		
12. ISSUING OFFICE US NRC - HQ ACQUISITION MANAGEMENT DIVISION MAIL STOP TWFN-8E06M WASHINGTON DC 20555-0001				13. LEGISLATIVE AUTHORITY Energy Reorganization Act of 1974		
				14. PROJECT ID EWA		
				15. PROJECT TITLE MELCOR MODELING OF ACCIDENT BASED RELEASES FROM A		
16. ACCOUNTING DATA 2018-X0200-REIM-60-60D002-60B207-1304-38-R-838-253D-DOE-GNEPTIE-31-38-R-838-1304						
17. ITEM NO.	18. SUPPLIES/SERVICES		19. QUANTITY	20. UNIT	21. UNIT PRICE	22. AMOUNT
	<p>The NRC and the DOE Sandia National Laboratory (SNL) hereby enter into this Task Order 31310018F0009 under Agreement, NRC-HQ-25-14-D-0005 for the project entitled, "MELCOR Modeling of Accident Based Releases from a Nuclear Fuel Reprocessing Facility".</p> <p>The performance period for this agreement shall commence on April 23, 2018 and will expire on May 1, 2019.</p> <p>Consideration and Obligations: Continued ...</p>					
23. PAYMENT PROVISIONS				24. TOTAL AMOUNT \$120,000.00		
25a. SIGNATURE OF GOVERNMENT REPRESENTATIVE (SERVICING)				26a. SIGNATURE OF GOVERNMENT REPRESENTATIVE (REQUESTING) 		
25b. NAME AND TITLE		25c. DATE	26b. CONTRACTING OFFICER JEFFREY R. MITCHELL		26c. DATE 05/11/18	

(a) Authorized Cost Ceiling \$207,686.00.

(b) The amount presently obligated with respect to this DOE Agreement is \$120,000.00. When and if the amount(s) paid and payable to the DOE Laboratory hereunder shall equal the obligated amount, the DOE Laboratory shall not be obligated to continue performance of the work unless and until the NRC Contracting Officer shall increase the amount obligated with respect to this DOE Agreement. Any work undertaken by the DOE Laboratory in excess of the obligated amount specified above is done so at the DOE Laboratory's sole risk.

The following documents are hereby made part of this Agreement:

Attachment No. 1: Statement of Work

NRC CONTRACTING OFFICERS REPRESENTATIVE (COR):

██████████ (Primary) ██████████ (Alternate)

SNL PROJECT MANAGER: ██████████

██████████

Master IAA: NRCHQ2514D0005

00001

Authorized Agreement Ceiling  
Total Obligated Amount: \$207,686.00  
Incrementally Funded Amount: \$120,000.00

207,686.00

This agreement is entered into pursuant to the authority of the Energy Reorganization Act of 1974, as amended (42 U.S.C 5801 et seq.). This work will be performed in accordance with the NRC/DOE Memorandum of Understanding dated November 24, 1998. To the best of our knowledge, the work requested will not place the DOE and its contractor in direct competition with the domestic private sector.

- [ X ] Fee Recoverable Work
- [   ] Non-fee Recoverable Work

Notwithstanding the agreement effective dates and period of performance start dates stated elsewhere in the agreement, the effective date of the agreement and start date of the period of performance are the last date of signature by the parties.  
Continued ...

ALC: 31000001  
DUNS: 040535809  
TAS: 31X0200.320

The total amount of award: \$207,686.00. The obligation for this award is shown in box 24.

## STATEMENT OF WORK (SOW)

<b>NRC Agreement Number</b>  NRC-HQ-25-14-D-0005	<b>NRC Agreement Modification Number</b>  	<b>NRC Task Order Number (If Applicable)</b>  31310018F0009	<b>NRC Task Order Modification Number (If Applicable)</b>  
<b>Project Title</b> <b>MELCOR Modeling of Accident Based Releases from a Nuclear Fuel Reprocessing Facility</b>			
<b>Job Code Number</b>  	<b>B&amp;R Number</b>  		<b>Servicing Agency</b>  Sandia National Laboratories
<b>NRC Requisitioning Office</b> RES		<b>Period of Performance</b> April 23, 2018 to May 1, 2019	
<b>NRC Form 187, Contract Security and Classification Requirements</b> <input type="checkbox"/> Applicable <input checked="" type="checkbox"/> Not Applicable		<input type="checkbox"/> Involves Proprietary Information <input type="checkbox"/> Involves Sensitive Unclassified	
<input type="checkbox"/> Non Fee-Recoverable		<input checked="" type="checkbox"/> Fee-Recoverable (If checked, complete all applicable sections below)	
<b>Docket Number (If Fee-Recoverable/Applicable)</b>  		<b>Inspection Report Number (If Fee Recoverable/Applicable)</b>  	
<b>Technical Assignment Control Number (If Fee-Recoverable/Applicable)</b>  		<b>Technical Assignment Control Number Description (If Fee-Recoverable/Applicable)</b>  	

**CONTRACTING OFFICER'S REPRESENTATIVE**

Contracting Officer's Representative

Name: [REDACTED]  
[REDACTED] Commission  
Office: [REDACTED]  
Mail Stop: [REDACTED]  
Washington, DC 20555-0001  
E-Mail: [REDACTED]  
Phone: [REDACTED]

Alternate Contracting Officer's Representative

Name: [REDACTED]  
[REDACTED] Regulatory Commission  
Office: [REDACTED]  
[REDACTED]  
Washington, DC 20555-0001  
E-Mail: [REDACTED]  
Phone: [REDACTED]

**GOVERNMENT-FURNISHED PROPERTY (GFP)**

Not Applicable

--- End of Executive Summary ---

## STATEMENT OF WORK (SOW)

### Contents

- 1.0 Background
- 2.0 Objective
- 3.0 Scope of Work/Tasks
- 4.0 List of Deliverables
- 5.0 Estimated Labor Categories, Key Personnel and Levels of Effort
  - 5.1 Labor Categories, Requirements and Key Personnel
  - 5.2 Level-of-Effort (in hours)
- 6.0 Certification and License Requirements
- 7.0 Meetings and Travel
- 8.0 Reporting Requirements
  - 8.1 Monthly Letter Status Report (MLSR)
  - 8.2 Reports
- 9.0 Required Materials, Facilities, Hardware/Software
- 10.0 Applicable Publications (Current Editions)
- 11.0 Data Rights

## DESCRIPTION/SPECIFICATIONS/WORK STATEMENT

### 1.0 BACKGROUND

In earlier work, the construction of a MELCOR model of a nuclear fuel reprocessing plant was performed by Clinton Shaffer for Sandia National Laboratories (SNL) under sponsorship by the U.S. Nuclear Regulatory Commission (NRC). The results of this project were contained in the draft report entitled “*Demonstration of MELCOR Analyses of a Nuclear Fuel Reprocessing Plant*” (Shaffer, 2016). The project demonstrated analytical techniques needed to apply the MELCOR code in safety assessments of any future, spent nuclear fuel reprocessing facility built in the United States.

Reprocessing plants contain both chemical and nuclear processes each with their own hazards and in many processes a combination of these hazards. Analyzing these hazards requires the simulation of operational and accident-driven airflows throughout the facility and to track the transport of contaminants from their point of release to their final deposition or release from the facility into the environment. This type of facility is designed with pressure zones so that the air flows from the least radioactive (or non-radioactive) areas to the most radioactive areas and then through a filtration process to clean the air before it is reintroduced into the environment via a tall stack. The NRC established a previous agreement with Sandia National Laboratory (SNL) to create a MELCOR code, which contains the necessary physics and engineering models to simulate airflow and fission product transport and deposition, including filtration of the airflows. The construction of a MELCOR model of a nuclear fuel reprocessing plant was initially performed by Clinton Shaffer for SNL, and the results of this project were contained in the draft report entitled: “*Demonstration of MELCOR Analyses of a Nuclear Fuel Reprocessing Plant*” (Shaffer, 2016). The project demonstrated analytical techniques needed to apply the MELCOR code in safety assessments of any future, spent nuclear fuel reprocessing facility built in the United States.

For the basis of the facility design, the Barnwell Nuclear Fuel Plant (BNFP) was chosen for this study. The Barnwell plant was constructed in the early 1970s to process spent nuclear fuel from commercial power reactors, but the now decommissioned plant was never used for that purpose.

For these analyses, MELCOR 2.1 Version RL\_NL\_8152 was used. A key challenge for using the Barnwell plant in the MELCOR code setting was the development of the control volumes needed to model the airflows and pressures to match the Barnwell facility design and/or operational flow and pressure data for the specific facility. Once this was done, example explosion and fire accidents were simulated to demonstrate the model's responses to these types of accident source terms.

Due to a large degree of uncertainty in the accident source terms, fission product releases from processing tanks and piping were simply sourced into the MELCOR calculations in trace amounts to estimate conservative leak path factors (LPF). This task order with SNL would allow more realistic source terms to be modelled with a variety of source terms, accident energies and accident sequences.

## **2.0 OBJECTIVE**

The objective of this project is to assess the impact of accidents at spent nuclear fuel reprocessing facilities due to explosions and/or fires related directly to nuclear fuel reprocessing. This includes an evaluation of the applicability of MELCOR for assessing accident consequences at nuclear fuel reprocessing facilities. This project also includes an evaluation of various leak pathways and the LPF for various scenarios.

## **3.0 SCOPE OF WORK/TASKS**

SNL shall provide all resources necessary to accomplish the tasks and deliverables described in this Statement of Work (SOW). The laboratory shall provide a final report that describes the modelling approach and results for a set of accident scenarios. The report shall include a summary, discussion and evaluation of calculated LPFs, as well as an evaluation of applicability of MELCOR to reprocessing facilities.

SNL shall perform MELCOR modelling using the model parameters, flow rates, and room volumes developed in an earlier task order (see "*Demonstration MELCOR Analyses of a Nuclear Fuel Reprocessing Plant*," C. Shaffer, 2016) for a spent nuclear fuel reprocessing facility. The model parameters may be refined and expanded by SNL, however, SNL shall clearly cite the adjusted parameters in the final report.

### **Task 1- Develop Accident Scenarios**

SNL shall develop a set of accidents (i.e., scenarios) to include a realistic range of energies, realistic masses of chemicals and radionuclides (source terms), and vapor properties. These

scenarios shall be described in a letter report. It is anticipated that a set of three energies for each of three mass/activity source terms will be used (plus a fire/explosion combination); for a total of 10 scenarios. These accidents shall include the following:

- Chemical explosions (especially red-oil explosions) that involve radionuclides
- Fires that involve radionuclides
- A combination of explosion and fire

### **Task 2- Perform Accident and Release Modelling**

Using the previously developed MELCOR model of the Barnwell reprocessing facility, task 2 shall focus on a set of accidents that result in damage to the facility and on the potential release of radionuclides to the environment. SNL shall model each type of event, using realistic chemical and radionuclide source terms as described in task 1. These events may be obtained from NUREG/CR-7168 and NUREG/CR-7232 which is available on the NRC's public website at: <https://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/>. It also may be possible to obtain information from existing European reprocessing facilities. For the explosion scenarios, SNL shall model a variety of energies associated with the explosions that fall within estimated ranges of actual events (e.g. 50 to 700 MJ), which have taken place in reprocessing facilities. When mutually agreed upon with the COR Modelling of aerosols generated during the events shall include distributions of particle sizes such as those presented by Gelband et al, (SAND2013-9268C) and shall include a combined explosion/fire scenario. The use of other literature based on basic principle approaches to generating parameters for input to the models is strongly encouraged.

While task 2 shall focus on explosions and fires, SNL shall discuss other types of accidents at reprocessing facilities such as criticality events, leaks, earthquake impacts as appropriate in the context of potential off-site releases. SNL shall submit a Draft Report and then a Final Report, incorporating NRC comments. The report shall contain the following:

- a description of each of the 10 accident scenario
- a description of model results and facility impacts from each scenario
- estimates of the degree of damage to and contamination of the facility
- an discussion of the pathways of contaminant transport
- quantities of radionuclides released from the facility
- a discussion of the Leak Path Factor (LPF)

SNL shall use the best MELCOR modelling practices as discussed in Louie and Humphries, 2017 (SAND2017-3200). A comparison of LPF from modelling to that of the DOE Handbook (DOE-HDBK-3010-94) shall be made.

The Final Report shall also reference selection, modeling, and results of the analysis of releases from reprocessing accidents. Results and descriptions from earlier work (i.e., Shaffer, 2016) shall be integrated into the report. SNL shall use NRC’s Word template for NUREG/CR reports in submitting the Final Report. The COR will provide the NRC Word template to SNL subsequent to award.

#### **4.0 LIST OF DELIVERABLES**

SNL shall submit all deliverables referenced in the table below electronically to the COR. Unless otherwise directed by the COR or the CO, SNL must provide all deliverables except the Monthly Letter Status Report (MLSR) as draft products. The COR will review all draft deliverables and provide comments back to SNL. SNL shall revise the draft deliverable based on the comments provided by the COR, and then resubmit the final version of the deliverable to the COR. More than one round of drafts may be needed if SNL does not successfully incorporate the COR’s comments on the previous draft. When mutually agreed upon between SNL and the COR, SNL may submit preliminary or partial drafts to the COR for the purpose of helping the COR to gauge SNL’s understanding of the particular work requirement.

<b>Task Number</b>	<b>Deliverable</b>	<b>Deliverable Format</b>	<b>Due Date</b>
1	Accident Scenario Letter Report	Microsoft Word	No Later Than (NLT) 60 calendar days from to task order award
2	Draft Report	Microsoft Word	NLT 9 months from to task order award
2	Final Report	Microsoft Word or Adobe PDF	NLT 30 calendar days from receipt of NRC comments on the Draft Report
All	Monthly Letter Status Report (MLSR)	Microsoft Word or Adobe PDF	NLT than the 20th of the following month

**5.0 ESTIMATED LABOR CATEGORIES, KEY PERSONNEL AND LEVELS OF EFFORT**

**5.1 Labor Categories, Requirements and Key Personnel.** Personnel working under this agreement/order shall meet the minimum requirements for experience and education, as follows:

Labor Category	Position Minimum Requirements	Key Personnel
Key Staff	Ph. D., Nuclear Engineering or similar	[REDACTED]
Key Staff	Ph. D., Nuclear Engineering or similar	[REDACTED]

**6.0 CERTIFICATION AND LICENSE REQUIREMENTS**

Not Applicable

**7.0 MEETINGS AND TRAVEL**

Not Applicable

**8.0 REPORTING REQUIREMENT**

SNL is responsible for structuring the deliverables to current NRC standards. SNL shall submit deliverables free of spelling and grammatical errors and shall conform to the requirements stated in this SOW.

**8.1 Monthly Letter Status Report (MLSR)**

SNL shall provide a MLSR which consists of a technical progress report and financial status report. This report will be used by the sponsoring agency to assess the adequacy of the resources utilized by the servicing agency to accomplish the work contained in this SOW and to provide status of the servicing agency progress in achieving tasks and producing deliverables. The report shall include agreement/order summary information, work completed during the specified period, milestone schedule information, problem identification and resolution, and staff hour summary. Copies must be sent to the COR and AMD at [ContractsPOT.Resource@nrc.gov](mailto:ContractsPOT.Resource@nrc.gov).

The MLSR shall include the following: agreement number; task order number; title of the project; project period of performance; task order period of performance; COR's name, telephone

number, and e-mail address; full name and address of the performing organization; principal investigator's name, telephone number, and e-mail address; and reporting period.

## **8.2 Reports**

See Section 4.0, List of Deliverables.

Acceptance Criteria for Task 2 Draft Report: SNL shall clearly describe the accident scenarios modeled, the modeling process, and results and interpretation. SNL shall submit the report in a Microsoft Word format.

Acceptance Criteria for Task 2 Final Report: SNL shall address all NRC comments and shall follow the format, content, and schedule described in this SOW.

## **9.0 REQUIRED MATERIALS, FACILITIES, HARDWARE/SOFTWARE**

SNL shall use the latest and most appropriate version of the MELCOR code to perform the modeling described in this SOW.

## **10.0 APPLICABLE PUBLICATIONS (CURRENT EDITIONS)**

SNL shall comply with NRC's NUREG report template, which the COR will provide to SNL subsequent to award.

## **11.0 DATA RIGHTS**

The NRC shall have unlimited rights to and ownership of all deliverables provided under this agreement/order, including reports, recommendations, briefings, work plans and all other deliverables. All documents and materials, to include the source codes of any software, produced under this agreement/order are the property of the NRC with all rights and privileges of ownership/copyright belonging exclusively to the NRC. These documents and materials may not be used or sold by the servicing agency without prior written authorization from the CO. All materials supplied to the NRC shall be the sole property of the NRC and may not be used for any other purpose. This right does not abrogate any other Government rights.